Predicting Framing Susceptibility in Health Decisions through Dual Process and Numeracy Theories

by

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Abstract

Multiple times per day individuals are faced with deciding what foods to consume and how much of these foods to consume. For most of us, the food decisions we make have direct implications on our health and weight. In the U.S. the health and weight status of the populous is a mounting concern and more than half of the citizens are now characterized as overweight or obese. The current studies sought to better understand what factors contribute to dietary decision making in order to better understand this problematic trend of obesity. In two studies, the way in which nutrition information (calories) was presented was altered to investigate whether different presentation formats influence participants' willingness to eat various foods. Further, several self-report measures were obtained to get a more comprehensive view of factors influencing eating behavior. It was expected that participants' willingness to eat various foods would vary based on the way the nutrition information was presented, with individuals demonstrating what is known as the framing bias. Some individuals have been found more susceptible to the framing bias, including those that are low in cognitive reflection and those low in numeracy abilities. In the current studies, participants' low cognitive reflection and numeracy did not appear vulnerable to the framing manipulations; however, participants low in confidence to resist eating high calorie foods did appear prone to differences in preferences due to framing. Furthermore, several self-report measures provided additional insight into important factors individuals' value when making dietary selections, such as price, convenience, and the natural content of their foods. In sum, the current studies provide evidence of factors influencing eating behavior and indicate

subsets of the population who may be prone to differences due to the framing of calorie information.

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List of Abbreviations

CDQ	Current Dieting Questionnaire
CRT	Cognitive Reflection Test
DIET-SE	Dieter’s Inventory of Eating Temptations – Self-Efficacy
FCQ	Food Choice Questionnaire

Introduction

Every day we make many decisions related to our health. For instance, we choose what to eat, how much to exercise, and how much alcohol to drink. Sometimes we may reflect on these decisions, whereas other times we may act using intuition or past experience. Each of these decisions varies in their positive or negative contributions to our health. For example, a potential drawback to repeated poor food decisions includes weight gain and potentially obesity. Currently in the U.S. more than two-thirds of the population is considered overweight or obese and hundreds of thousands of people die every year as a direct consequence of obesity (Ogden, Carroll, Kit, & Flegal, 2012). The food decisions an individual makes may have direct consequences for their risk of obesity, as well as additional health consequences related to obesity, such as heart disease.

The current research sought to further understand obesity-related factors by examining how one’s willingness to eat foods differed based on presenting the same caloric information in different ways. In the first study, caloric information was presented in a unit frame (Example: 2 slices of pizza, with each slice containing 300 calories) or package frame (Example: 2 slices of pizza, with a total of 600 calories) to determine if type of frame elicited differences in preferences. Framing preferences have been examined in the decision making literature, with measures of dual process and numeracy predicting the magnitude of preferences. As such, dual process and numeracy measures were examined as potential predictors of preference, and pertinent literature concerning dual process theories, numeracy theories, and health framing are discussed in the next sections.

Dual Process Theory

According to dual process theories of decision making, two cognitive systems guide how decisions are made: an intuitive system 1 and a reflective system 2. Although these systems often interact when making decisions, research has defined features of each system that make them distinguishable. System 1 processes are typically effortless, fast, implicit, and automatic (Kahneman, 2003). This intuitive system relies on automaticity and responses that quickly come to mind to solve a variety of problems and make choices. System 2 processes, on the other hand, are characterized by increased deliberation and conscious monitoring of decisions (Kahneman, 2003).

Typically, dependence on system 1 processes is sufficient for decision making, leading to a good decision in an effective, time-efficient manner, without sacrificing decision quality (Milkman, Chugh, & Bazerman, 2009). Often, we may encounter situations where prior experience leads to an established default response. For instance, once we have identified the fastest route, there is no need to reflect on which way to drive home from work each day. This default response can be used each time, utilizing only system 1 processes, with little cognitive effort applied in each instance. However, there are occasions where it is necessary to deliberate more about a problem in order to ascertain the correct solution, or to make the best possible choice. In these instances, better choices often result when system 2 operations are engaged (Frederick, 2005). Using the example of driving home, if I have intuitively started to take my usual route home without reflecting on this decision, I may forget that I was tasked with picking up milk from the store today. When system 2 processes are utilized individuals typically apply more effort to their decision, take more time, and deliberate on alternatives in order to make the best possible decision (Kahneman, 2003; Milkman et al., 2009). In situations in which an intuitive system 1 decision may be inaccurate, dependence on system 1 thinking may lead to poor decisions if reflective system 2 processes are not engaged (Kahneman, 2003). In other words, when activated, system 2 processes serve to supervise decision making, ensuring the best possible decision is made given the available information.

Dual process theory and the interplay between system 1 and 2 processes have been explored in various domains of decision making, including financial (Cokely & Kelley, 2009; Frederick, 2005) and consumer decisions (Obrecht, Chapman, & Gelman, 2007). However, research utilizing dual process theory in the domain of health decisions remains underexplored. Evaluating health decisions from a dual process theory point of view has the potential to shed light on a previously overlooked group of consumers. If an individual differs in their propensity to engage system 2 processes, differences in health decision making may result. For instance, those less likely to apply system 2 processes may fail to reflect on the poor nutritional value of their after-dinner snacks.

Cognitive Reflection

In order to examine the propensity of an individual to engage system 2 processes a simple validated measure known as the Cognitive Reflection Test (CRT) can be used (Frederick, 2005). The CRT is an efficient method to ascertain whether an individual prefers to depend on system 1 or system 2 processes, as items are designed so that it is easy to come up with a common intuitive response. However, the items are structured so that this intuitive response is incorrect. In order to correctly answer the items, most individuals need to engage system 2 processes, reflect on their original incorrect answer, and adjust accordingly. Frederick describes the CRT as measuring "“cognitive reflection” – the ability or disposition to resist reporting the response that first comes to mind" (p. 35).

For example, the first item reads as follows: “A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?” Often people will incorrectly answer that the ball costs $0.10. However, if the ball costs $0.10, and the bat costs $1.00 more than the ball, then the bat must cost $1.10, bringing the total of the bat and the ball to $1.20, violating the first statement. If individuals reflect on their answer of $0.10 they should see that $0.10 cannot be the correct answer, their calculating system 2 operations should reveal as much using only simple addition calculations. Similarly, if individuals conclude that the ball costs $0.10, and the total of the bat and ball is $1.10, then the bat must cost $1.00 to achieve this total. However, this difference between the bat cost of $1.00 and the ball cost at $0.10 would only be $0.90, not the $1.00 difference necessary to fulfill the second statement. From this perspective, again individuals’ system 2 processes should demonstrate that their intuitive answer of $0.10 cannot be correct. The CRT items, as well as the incorrect intuitive answers and the correct answers, are listed in Appendix A.

The CRT items may appear relatively easy, however many individuals do not answer these items correctly. For instance, students at the University of Michigan at Ann Arbor had an average accuracy of only 39% (Frederick, 2005). For those that fail to correctly answer these items, in one study an overwhelming majority (89%) of incorrect answers were the incorrect intuitive answers (Oechssler, Roider, & Schmitz, 2009). Therefore, it appears a majority of people are answering in accordance with system 1 processes and not providing alternative answers, which may or may not utilize system 2 processes.

Decision making

Research demonstrates that the CRT provides a guide for who has a stronger propensity to make decisions in accordance with system 1 processes, which in many instances has been shown to lead to poorer decision making. There are observable differences on a variety of decision making tasks between those that answer incorrectly and those that engage their system 2 operations and answer correctly (Cokely & Kelley, 2009; Frederick, 2005; Oechssler et al., 2009; Toplak, West, & Stanovich, 2011). Those with poorer CRT performance are more likely to succumb to decision biases (Oechssler et al., 2009; Toplak et al., 2011), choose smaller immediate rewards (Frederick, 2005), and make riskier hypothetical financial decisions (Cokely & Kelley, 2009).

More specifically, Frederick (2005) observed differences between those individuals categorized as "high" in CRT performance (answering all 3 original items correct) and those "low" in CRT performance (answering 0 out of 3 items correct) when choosing between hypothetical rewards in an intertemporal choice task. In this choice task, participants were presented with two different monetary amounts, which were each paired with different time delays, and asked which option they would prefer. Interestingly, when asked to choose between a larger later reward and a smaller immediate reward, those with low CRT performance were less likely to choose the larger later reward. For example, 60% of the high CRT group said they would rather have $3800 next month as opposed to $3400 this month, though only 35% of the low CRT group responded in a similar manner in choosing the larger later reward. Additionally, when asked how much they would pay to get overnight shipping of a book of their choosing, those with low CRT performance reported they would pay significantly more to have the book sooner. Lastly, when directly asked, "How impulsive are you?" the low CRT group reported significantly higher impulsivity than the high CRT group.

CRT performance has been further compared to a wide range of decision making measures, including questions designed to assess susceptibility to biases (Oechssler et al., 2009;

Toplak, et al., 2011). In one study, CRT performance was compared to inclinations towards the conjunction fallacy (Oechssler et al., 2009). The conjunction fallacy is incorrectly indicating that the probability of two attributes is greater than the probability of only one attribute. The authors found those with low CRT performance were more likely to exhibit the conjunction fallacy. Therefore, those with low CRT performance may have reduced understanding of probabilities and increased sensitivity to decision biases, which may harm future decision making.

An additional analysis compared CRT performance with answers on 15 classic heuristics and biases problems (Toplak, et al., 2011). These heuristics and biases problems included a base-rate item, two sample size problems, and a framing problem (disease problem from Tversky and Kahneman (1981)), to name a few. A high positive correlation between CRT performance and the composite score from the 15 heuristics and biases problems was revealed, $r(344) = .44$, $p < .01$. Thus, those that perform poorly on the CRT, and have a stronger propensity to depend on system 1 processes, appear more likely to succumb to common decision and statistical biases.

Further illustrating the relationship between low CRT performance and poorer decision making, Cokely and Kelley (2009) found that the proportion of choices in accordance with expected value was significantly positively correlated with CRT performance. Expected value is a probability-weighted average of all possible values. When choosing between a certain gain option (e.g., 100% chance to gain $275) and a risky gain option (e.g., 20% chance to gain $900), a choice consistent with expected value would be choosing the 100% chance of gaining $275 (1.0 x $275), as the expected value for the risky option comes to only $180 (0.2 x $900). The higher the participants CRT performance the more likely they were to choose the option with the better expected value and larger potential monetary value. These findings demonstrate that those participants that performed well on the CRT, and made more choices in accordance with expected values, seem better able to resist the urge to depend solely on system 1 processing. Instead, these individuals appear more likely to use system 2 operations to think through and deliberate on their choices before making decisions.

Interestingly, dual process theories and the CRT are not the only indicators that have been shown to predict susceptibility to biases and substandard decision making. For instance, measures of numeracy, which quantify the ability to understand numbers, have also been shown to predict poor decision making (e.g., Cavanaugh et al., 2008; Lipkus, Samsa, & Rimer, 2001; Peters et al., 2006). When decisions involve understanding and utilizing numeric information, it is expected that numeracy will play a role. As the current studies utilized numeric caloric information as part of the framing manipulations, a discussion of theories of numeracy is essential.

Numeracy

Numeracy is defined as the ability to understand probabilistic and mathematical concepts (Lipkus et al., 2001; Peters, 2012). Numeracy is typically measured by asking individuals to translate numeric information from one form to another, such as translate percentages into frequencies or decimals, and make sense of numeric information. Lipkus et al. (2001) and Schwartz, Woloshin, Black, and Welch (1997), among others, have demonstrated that many individuals today may have trouble understanding numbers and quantitative information. The National Adult Literacy survey, which contains a quantitative literacy subsection as one of its three main components, supports this notion (Kutner, Greenberg, Jin, Boyle, Hsu, & Dunleavy, 2007).

The Literacy survey categorizes quantitative literacy into four levels of proficiency: below basic, basic, intermediate, and proficient (Kutner et al., 2007). Basic quantitative literacy is characterized by the ability to perform “one-step problems when the arithmetic operation is specified or easily inferred.” Intermediate quantitative literacy involves solving “problems when the arithmetic operation is not specified or easily inferred” (Kutner et al., 2007, p. 4). Results from the most recent 2003 survey demonstrated that 55% of American adults fall into the below basic or basic category. These adults are able to do only simple mathematical operations and cannot perform multi-step calculations (Kutner et al., 2007). Additionally, the survey has indicated that vulnerable populations that have poor numeric skills include Hispanics and African Americans (Peters, 2012). Given the scope of the current project, it should be noted that these groups have also been identified as having the highest rates of obesity among both children and adults (Ogden et al., 2012).

Similar to dual process theories, difficulties with numeracy have been shown to impact financial decision making (Cokely & Kelley, 2009) and susceptibility to biases (Peters et al., 2006). Numeracy has also consistently demonstrated an influence in health decision making (e.g., Cavanaugh et al., 2008; Marden et al., 2012), whereas dual process theories have not yet been substantially explored in this domain. Furthermore, a modest positive correlation has been found between measures of numeracy (Lipkus et al., 2001) and measures of dual process propensities (Cokely and Kelley, 2009; Frederick, 2005). The relationship between these measures indicates that those who engage in system 2 processing are also more likely to have stronger numeracy abilities. The similarities and differences between numeracy and dual process theories in their capabilities to predict decision making and bias tendencies, as well as the correlation between these measures, suggests that both dual process theories and numeracy impact health decision making.

Numeracy and Health

Previous literature has shown that numeracy may predict inabilities to understand common health risks when expressed statistically (Rolison, Hanoch, & Miron-Shatz, 2012; Schwartz et al., 1997). Further, numeracy can also predict how well individuals can perform routine maintenance for their chronic health conditions such as diabetes (Cavanaugh et al., 2008; Marden et al., 2012). It appears that with reduced numeracy abilities substandard health decision making may result, presenting concerns for both current and long-term health.

Both women and men scoring low in common objective numeracy scales have been shown to often misinterpret or misunderstand health risks (Rolison et al., 2012; Schwartz et al., 1997). In one study, female veterans low in numeracy were found less likely to accurately assess the benefit of a mammogram in reducing their risk of death from breast cancer (Schwartz et al., 1997). Those with lower numeracy perceived their risk of death from breast cancer was more greatly reduced with a single mammography than the data supported.

Similarly, Rolison et al. (2012) sampled male participants and again those lower in numeracy were found to be more likely to misinterpret health risks. Participants were presented with statistical information vignettes about their lifetime risk of prostate cancer and asked which of four interpretations was the most accurate. Participants were provided with the following statistical information:

> According to estimates of lifetime risk, about 12% (120 out of 1,000 individuals) of men in the general population will develop prostate cancer, compared with estimates of 24% to 60% (240–600 out of 1,000) of men who smoke. In other words, men who smoke are 2 to 5 times more likely to develop prostate cancer than men who do not smoke. (Rolison et al., 2012, p. 531)

The most accurate interpretation choice for this vignette was "Prostate cancer will develop in 24% to 60% of men who smoke." Only 38% of the participants correctly selected this option (p. 531). Instead, a majority selected the following incorrect option: "Men who smoke have a 24% to 60% higher chance of developing prostate cancer than men who do not smoke" (p. 531). For those found to be lower in numeracy these participants were even less likely to correctly identify the appropriate interpretation. Thus, individuals lower in numeracy are more likely to conclude that they have a 24% to 60% greater chance of developing prostate cancer if they smoke. However, what the information actually conveyed was that the cancer risk was 2 to 5 times more likely if they smoked than if they did not smoke. This is a drastic difference as instead of a 24% to 60% increase in risk, they actually have a 100% to 400% increase in risk of cancer if they smoke. Misinterpretations of risks by those low in numeracy may lead to increased underestimates of the odds that unhealthy behaviors will lead to negative health outcomes in the future.

Numeracy has also been shown to predict management of chronic health conditions. In studies of both U.K. and U.S. samples the link between numeracy and glycemic control in diabetic patients has been examined (Cavanaugh et al., 2008; Marden et al., 2012). Being able to numerically track food intake is of concern for many people, but especially so for those with diabetes. This population has to closely monitor their carbohydrate intake and adjust their insulin doses accordingly in order to maintain glycemic control. Tracking carbohydrate intake and adjusting insulin doses appropriately undoubtedly takes numeric skills. Unfortunately, the ability to properly maintain glycemic control was found to be severely diminished in those with poor numeracy skills (Cavanaugh et al., 2008; Marden et al., 2012).

For instance, 47% of the participants in one study performed in the U.K. were found to have numeracy skills below what experts believe are necessary to properly implement glucose control strategies (Marden et al., 2012). Not surprisingly, results indicated that those low in numeracy also had significantly reduced glycemic control, as indicated by increased levels on an HbA_{1c} test, a common measure used to assess glycemic control in which a lower score is indicative of greater diabetes management. This diminished ability to maintain healthy glycemic control is not surprising given that these individuals appeared to lack the numeracy skills necessary to calculate their intake and adjust their insulin doses appropriately.

Similar results have been observed in a U.S. sample of diabetics (Cavanaugh et al., 2008). In this study, results demonstrated that 69% of the participants had less than ninth-grade general numeracy skills and those in the bottom quartile in numeracy performance had significantly higher HbA_{1c} results than those in the top quartile. Further, participants who were higher in numeracy performance were more likely to have increased diabetes knowledge and increased perceived self-efficacy of diabetes self-management behaviors. For those with less than adequate numeracy and associated decreased glycemic control, these individuals appear more susceptible to diabetes-related detrimental health outcomes, such as chronic kidney disease (Cavanaugh et al., 2008; Marden et al., 2012). Without necessary numeracy skills those with diabetes, and presumably other health conditions in which tracking of consumption in conjunction with medication is necessary, would appear to have a higher risk of additional serious negative health outcomes.

Susceptibility to Framing

Previous research has also shown that those lower in numeracy are more likely to succumb to a decision bias known as framing (Peters et al., 2006). Daniel Kahneman and Amos

Tversky have observed that “reversals of preference by variations in the framing of acts, contingencies, or outcomes” may occur (Tversky & Kahneman, 1981, p. 453). The framing bias occurs when the same information is presented in different ways and leads to shifts in participants’ preferences (Peters, 2012; Tversky & Kahneman, 1981). For example, a classic framing study found that perceptions of beef quality differed when the ground beef is labeled as “75% lean” rather than “25% fat” (Levin & Gaeth, 1988). As discussed earlier, Toplak et al. (2011) observed an influence of dual process theory with regard to susceptibility to framing, as those with lower CRT performance showed a larger susceptibility to biases, including the framing bias. In Peters et al. (2006) lower numeracy participants demonstrated increased susceptibility to framing when asked to rate the quality of hypothetical students’ work. Participants completed the task in a positive frame, where the student was described as getting 74% correct, or a negative frame, where the student was described as getting 26% incorrect. Though the overall results demonstrated the presence of the framing bias, the bias was significantly larger in participants low in numeracy. Those in the lowest quartile of numeracy were found to have a significantly larger average difference between the positive and negative frames compared to those in the highest quartile of numeracy, suggesting the influence of framing may be augmented in low numeracy groups.

An additional examination of the relationship between numeracy and framing used 5 variants of the Asian Disease problem, including the classic variant which reads as follows:

> Sweden is preparing for the outbreak of an unusual disease, which is expected to kill 600 people. The following alternative programs have been proposed to limit the spreading of the disease: If Program A is adopted, 200 people will be saved. If Program B is adopted, there is a 1/3 probability that 600 people will be saved, and a 2/3 probability that no

people will be saved. (Peters & Levin, 2008, p. 446)

The above is an example of the gain frame variant of this classic problem. In the loss frame variant, the initial half is the same as the gain frame, however, the latter half is altered to focus on lives lost instead of lives saved. Upon reading the variant in either the gain or the loss frame, participants were asked to provide their preference, as well as provide attractiveness ratings for each of the options. In this study, numeracy was found to influence the ratings of the attractiveness of the sure options (Program A). For those low in numeracy their mean difference in attractiveness ratings between the gain and loss frames of the sure options was larger and significantly different, though the ratings for those high in numeracy were not significantly different. As the low numeracy participants rate the options as more or less attractive than their high numeracy counterparts, it appears as though those lower in numeracy are more likely to be swayed by the way in which the information is framed.

Numeric Framing

Academic researchers are not the only group to observe that individuals are susceptible to change their preferences when frames are altered. Parties such as the U.S. federal and state governments have even used frames to promote certain preferences. For instance, speed limits are framed as limits, and not suggestions, with the hope that limits and speeding laws will help to keep roadways safer. Health information is no exception to these frames, and many national organizations and government agencies (e.g., Department of Health and Human Services) use frames to attempt to guide health behavior. One way health information is framed for the populous is through Nutrition Facts panels. These panels are present on almost all packaged foods sold in industrialized nations and the U.S. has utilized these panels since the Nutrition Labeling and Education Act of 1990. It is important to note that research has found that U.S.

consumers are using these panels in making food selections. A U.S. phone survey from 2008 found that 54% of consumers say they read the Nutrition Facts panel before buying a product for the first time (Choiniere & Lando, 2010).

Nutrition Facts panels detail the nutrients that are present in packaged foods and typically include categories such as calories, fats, carbohydrates, sodium content, protein, and vitamins to name a few. These panels may act as frames as they often utilize serving sizes, where the nutrients contained in the food are presented for the amount in a single serving. Given this presentation format these panels come with an inherent suggestion that the consumer have only one serving. Importantly, there is a caveat that there are often multiple servings within a single package. For example, a bag of potato chips may have 150 calories in a single serving of 15 potato chips, while the entire bag, containing 10 servings, contains 1500 calories.

A serving size on a Facts panel may include identifiable units such as 3 cookies, or an enigmatic 150 grams of cookies. Although serving sizes may have been designed to aid in tracking consumption and perhaps inspire individuals to eat in moderation, these serving sizes may potentially impair consumption in two ways. First, when serving sizes are presented in grams or ounces individuals may not understand when they have consumed a single serving or more of a particular food. Grams and other similar units of measure may not be an easy way for Americans, many of which may be less familiar with the metric system, to track consumption. Secondly, the nutritional content of one's total consumption may become difficult to calculate when more than one serving size of a particular food is consumed. This may be especially difficult when consuming partial servings, such as 1.5 or 2.25 servings, or some other non-whole number of servings. Using the cookie example, if the serving size for chocolate chip cookies is 3 cookies, which contain 225 calories, and I eat 7 of them, then I consumed 2.33 servings of cookies. Mentally calculating my total caloric consumption of cookies in this instance is not as straightforward as simply reading the Nutrition Facts panel for many of us (~524 calories is the answer).

Furthermore, the ability to use these Nutrition Facts panels may be influenced by dual process theories and numeracy abilities. For instance, dual process theories suggest that those are more apt to engage system 2 processes may be more likely to use these panels to reflect on their health choices, monitor their dietary selections, and/or track their consumption. Those that are less likely to engage system 2 processes may also be less likely to recognize that they have consumed more than a single serving of a food. Numeracy abilities may also influence the ways in which individuals use Nutrition panels. In instances of partial serving consumption, for many individuals somewhat more complex math may be necessary in order to ascertain the total caloric, fat, and sodium content for example. Those with poorer numeracy skills may be even less able to accurately calculate their total consumption. The U.S. Food and Drug Administration (FDA) appears aware of this serving size versus total consumption problem and has proposed that packages that could reasonably be consumed in one sitting, but contain multiple servings, such as a pint of ice cream, have a dual column label indicating both the per serving and per package nutrition information. Unfortunately, this dual column label would still not solve the problem of partial serving consumption (Example: 2/3 of the pint of ice cream).

With increased numeracy skills and increased cognitive reflection paid to the choices they make, some individuals may be better able to effectively attend to and utilize Nutritional Facts panels in making food choices. Similarly, these individuals may be better able to avoid succumbing to decision biases. However, for those lower in numeracy and cognitive reflection, they may be more susceptible to a framing bias of nutritional information.

Summary

The decision consequences of dependence on system 1 versus system 2 processing have been illustrated through recent studies (Cokely & Kelley, 2009; Frederick, 2005; Oechssler et al., 2009; Toplak et al., 2011). Research has found that those that depend more on system 1 processing to make decisions typically make substandard decisions, are less patient, choose more immediate rewards (Frederick, 2005), and are more likely to succumb to decision biases such as framing (Oechssler et al., 2009; Toplak et al., 2011). Additionally, dependence on system 1 processing has been found to correlate with poorer performance on a common test of numeracy (Cokely & Kelly, 2009). Those deficient in numeracy have also showed increased susceptibility to framing and substandard health decision making when numeric information is involved (Cavanaugh et al., 2008; Marden et al., 2012; Peters et al., 2006; Peters & Levin, 2008). These findings suggest that dual process and numeracy theories may have an impact on susceptibility to framing with regard to health decisions involving numeric information.

The current studies sought to examine dual process theory, through use of the CRT, and numeracy, through the 11-item Lipkus et al. (2001) numeracy scale, and determine if there is a connection between differences in processing dependence and/or numeracy with regard to susceptibility to framing of health decisions. In two studies, participants were provided with the same information about the caloric values of foods, but this information was presented in different ways within each study. In the Food Task in study 1, unit and package frames were contrasted, whereas the study 2 Food Task compared numeric and pie chart frames. In both studies, participants were asked to rate their willingness to eat the amount of food described. As dual process theories and numeracy have been found to predict susceptibility to framing (Peters et al., 2006; Toplak et al., 2011), CRT and numeracy performance have been correlated (Cokely

& Kelly, 2009), and those low in numeracy have been found to make less than optimal decisions in the health domain (Cavanaugh et al., 2008; Marden et al., 2012), it was expected that numeracy and CRT performance would predict willingness to eat ratings.

An investigation of dual process theories, numeracy, and the framing bias in the health domain is further important given the ongoing obesity epidemic currently taking place in America, with more than a third of the nation currently classified as obese and more than two-thirds classified as overweight or obese (Ogden et al., 2012). The risk of Type II diabetes, heart disease, stroke, cancer and even mental health problems have been shown to be significantly higher in obese versus non-obese populations as well (Expert Panel on the Identification, Evaluation, and Treatment of Overweight in Adults, 1998). As a result of these long-term health consequences associated with obesity, an estimated $147 billion is spent annually on obesity related medical expenses and an estimated 112,000 people die per year as a direct result of obesity (Finkelstein, Trogdon, Cohen, & Dietz, 2009; Flegal, Graubard, Williamson, & Gail, 2005). Consequently, the current studies are warranted, timely, and necessary.

Study 1 Hypotheses

Previous work has found a modest correlation ($r(62) = .29$, $p < .05$) between numeracy and CRT scores (Cokely & Kelley, 2009).

***Hypothesis 1*:** I hypothesized that numeracy and CRT performance would be modestly correlated in study 1.

Those that perform more poorly on numeracy and CRT measures have been shown more likely to succumb to decision biases, including the framing bias (Peters et al., 2006; Toplak et al., 2011). For instance, those low in numeracy have demonstrated a larger difference in ratings between frames compared to those high in numeracy (Peters et al., 2006). I expected to find increased susceptibility to framing in Study 1 by those low in CRT and/or numeracy performance.

Hypothesis 2**:** I hypothesized that numeracy scores, CRT scores, and/or frames (unit or package) would be significant predictor variables of willingness to eat ratings.

In the Food Task, participants in the unit frame viewed food scenarios presenting calories in a per unit manner (Example: 50 calories in each cookie). To obtain the total calories, I expected many individuals would attempt to multiply the calories in a unit by the number of units (Example: 5 cookies x 50 calories per cookie = 250 calories).

Hypothesis 3**:** If people were calculating total calories in the unit frame, I hypothesized reaction times for ratings would be longer for the unit frame than for the package frame, where no additional calculations were necessary.

In order to find convergence between willingness to eat ratings in the Food Task and self-reported food eating behavior, the Food Choice Questionnaire (FCQ), Dieter's Inventory of Eating Temptations – Self-Efficacy (DIET-SE), and Current Dieting Questionnaire (CDQ) were utilized in the current studies. The FCQ contains 9 subscales, including health, natural content, sensory appeal, mood, and weight control and ascertained the importance of each of the 9 factors for each individual. Across two studies, strong correlations have been found between health, natural content, mood, and weight control factors with selecting healthier options in a choice task, suggesting that these factors are important correlates of food preferences (Jackson, Franco-Watkins, & Gillis, in preparation). The DIET-SE consists of 3 factors: High-Caloric Food, Social and Internal Factors, and Negative Emotional Events. I anticipated that correlations between both FCQ and DIET-SE factors and ratings would emerge in the current study.

Additionally, it was anticipated that those currently dieting, as measured by the CDQ, would have lower food ratings.

Hypothesis 4**:** I hypothesized that sensory appeal and mood ratings from the FCQ would be positively correlated with willingness to eat ratings, whereas health and weight control ratings would be negatively correlated with willingness to eat ratings.

Hypothesis 5**:** I hypothesized that high-caloric food confidence ratings from the DIET-SE would be negatively correlated with food ratings.

Hypothesis 6: Those currently dieting were hypothesized to have lower food ratings, as represented by a negative correlation between CDQ scores and food ratings.

Study 1 Method

Participants

One hundred undergraduate students from Auburn University participated in Study 1. Participants were recruited through Auburn University's Psychology Department SONA Systems. Study 1 took less than 30 minutes to complete and participants were compensated with extra credit for their time. Using the effect size ($\eta^2 = .11$) from a significant interaction between frames and numeracy found in Peters et al. (2006), a power analysis using a power of .80 indicated that at least sixty-six participants were necessary to replicate the effect size. Five participants were removed from analyses because their Food Task ratings were greater than two standard deviations from the mean. Hence, the analyses are based on 95 participants (21 males, 73 females, 1 non-specified). 65% of the sample was 18 years old, 12% were 19 years old, 10% were 20 years old, 8% were 21 years old, and 5% were 22 years old or older. Forty-seven participants were randomly assigned to the package frame, while forty-eight were randomly assigned to the unit frame.

Design

Multiple linear regressions were utilized in study 1. Numeracy scores, CRT scores, and frames (unit or package) were evaluated for their ability to predict willingness to eat ratings and reaction time when making ratings. Type of frame was treated as a between-subjects variable, whereas all participants completed the same numeracy and CRT measures. Additional ANOVA analyses examined whether interactions or main effects were present between DIET-SE ratings and frames, with willingness to eat ratings and reaction time as dependent variables. Lastly, Pearson correlation analyses investigated whether ratings were correlated with subscales of the FCQ, DIET-SE, and CDQ.

Materials

Cognitive Reflection Test

A three item CRT scale has been widely used (Frederick, 2005); however, given the poor accuracy found with Auburn University students in previous studies, an additional four items were added to better capture dual process propensities in this sample. Three of these items came from an already validated expanded CRT (Toplak, West, & Stanovich, 2014), and one item was created by the author. The seven items are included in Appendix A, along with the intuitive incorrect answers and the correct answers. Answering these items incorrectly was characterized as engaging only system 1 processes, whereas answering correctly was taken as an indication of engagement and utilization of system 2 processes. If participants had lower accuracy scores, this was taken as an indication that they have a stronger propensity to depend on system 1 processes. Participants had as much time as they needed to respond to each item and typed their answers into a box on a computer screen.

Numeracy Scale

The 11-item Lipkus et al. (2001) numeracy scale was utilized to determine a numeracy score for each participant. This scale asks participants to compare frequencies, translate frequencies into percentages, convert percentages into frequencies, convert decimals into frequencies, and other similar comparisons of numbers across different representation formats. For example, one item asks participants, "The chance of getting a viral infection is .0005 out of 10,000 people, about how many of them are expected to get infected? [Answer = 5] (See Appendix A for all numeracy items). Participants typed their answer where appropriate or selected their answer from a choice of 3 using the number pad on the keyboard.

Food Task

The Food Task required participants to rate their willingness to eat a selected amount of a given food. Participants completed the Food Task in either the unit or package frame. The unit frame asked participants their willingness to eat *x* amount of a food, if each unit is *y* calories. In the package frame participants were asked their willingness to eat *x* amount of a food, given that this total is *z* calories. As an example, in the unit frame, participants were presented with chocolate chip cookies and asked to indicate how willing they were to eat 5 cookies at 50 calories apiece on a scale from 1(very unwilling) to 7(very willing). For the package frame, participants were asked to indicate their willingness to eat 5 cookies given that the total consumption is 250 calories. Images matching the type and amount of food described were presented on the screen during participants' ratings. For example, when participants were asked about their willingness to eat 5 cookies, an image of 5 cookies was simultaneously presented on the screen. Participants provided willingness to eat ratings for 32 scenarios presented on a standard laboratory computer, including entrees, snacks, fruits, and vegetables. However, fruits and vegetables were excluded from analyses due to their low caloric nature (Example: 7 cherries at 5 calories apiece), which left 22 scenarios for analysis. Participants recorded their responses using the number pad on the keyboard. Instructions and sample stimuli are included in Appendix A.

Food Choice Questionnaire

The Food Choice Questionnaire (FCQ) was used to determine influences for individuals' dietary selections (Steptoe, Pollard, & Wardle, 1995). The FCQ uses the following stem: "*It is important to me that the food I eat on a typical day"* to assess different factors that contribute to dietary selections such as: "*takes no time to prepare*." The measure consists of a total of 36 items, broken down into nine factors: Health, Mood, Convenience, Sensory Appeal, Natural Content, Price, Weight Control, Familiarity, and Ethical Concern (See Appendix A for all FCQ items). For each item participants responded using the following scale: 1 = not important at all, 2 = a little important, 3 = moderately important, 4 = very important. Scores for each factor were computed by averaging the responses per factor and thus can range from 1 to 4 per factor, with higher scores indicative of greater importance for a specific factor. In this sample, the FCQ was reliable ($\alpha = .83$) with a mean of 2.44 ($SD = 0.33$) where mean scores ranged from 1.69 to 3.24. Additionally, the scores for each factor are as follows: Health ($M = 2.71$, $SD = 0.58$, $\alpha = .81$), Mood ($M = 2.41$, $SD = 0.67$, $\alpha = .81$), Convenience ($M = 2.80$, $SD = 0.66$, $\alpha = .79$), Sensory Appeal ($M = 2.85$, $SD = 0.59$, $\alpha = .64$), Natural Content ($M = 2.15$, $SD = 0.74$, $\alpha = .82$), Price ($M = 2.94$, $SD = 0.81$, $\alpha = .85$), Weight Control ($M = 2.54$, $SD = 0.74$, $\alpha =.77$), Familiarity ($M = 2.07$, $SD = 0.67$, $\alpha = .66$), and Ethical Concern ($M = 1.49$, $SD = 0.50$, $\alpha = .59$).

Current Dieting Questionnaire

The Current Dieting Questionnaire (CDQ) is a three-item measure that was used to establish if a participant is currently trying to diet or eat less in order to lose weight. Items include statements such as, “I am trying to lose weight by eating less,” in which participants indicated true/false or yes/no, by using the 1 and 2 keys on the number pad of the keyboard (See Appendix A for all CDQ items). The CDQ has been found to be a valid indicator of an individual’s current dietary status (Williamson et al., 2007). This questionnaire has been reversed scored in analyses, such that higher scores indicate increased dieting. The CDQ scores ranged from 1 to 2, with a mean of 1.45 (*SD* = 0.41).

Dieter’s Inventory of Eating Temptations – Self-Efficacy

The Dieter’s Inventory of Eating Temptations – Self-Efficacy (DIET-SE) is an 11-item measure that asked participants to indicate their confidence in their ability to resist certain dietary temptations (Stich, Knäuper, & Tint, 2009). The measure consists of 3 factors: High-Caloric Food, Social and Internal Factors, and Negative Emotional Events. Items include questions such as, “There is a party at work for a coworker and someone offers you a piece of cake. How confident are you that you would turn it down?” For each item participants responded using the following scale: 0 = not at all confident, 1 = a little confident, 2 = moderately confident, 3 = quite confident, 4 = very confident. Scores for each factor were computed by averaging the responses per factor and thus can range from 0 to 4 per factor, with higher scores indicative of increased confidence in their ability to resist the temptations. Instructions and all DIET-SE items are included in Appendix A. This measure maintained strong reliability ($\alpha = .78$), with a mean of 2.17 (*SD* = 0.73), where mean scores ranged from 0.17 to 4.00. The scores for each factor are as follows: High-Caloric Food (*M* = 1.83, *SD* = 1.02, $\alpha = .75$), Social and Internal Factors (*M* =

2.15, *SD* = 0.92, α = .69), and Negative Emotional Events (*M* = 2.53, *SD* = 1.03, α = .72). For the purpose of analyses, DIET-SE confidence was coded into four levels as follows: mean scores ranging from 0 - .99 = 1, 1 - 1.99 = 2, 2 - 2.99 = 3, and 3 – 4.00 = 4.

Demographic Questions

Additional characteristics of the participants were also obtained through several demographic questions. These questions ascertained age, gender, height, weight, dieting status, and exercise status. Additionally, participants were asked about their eating behaviors with questions such as, "How often do you check Nutrition Facts panels before purchasing or eating items?" The full list of demographic questions is included in Appendix A.

Procedure

Upon arrival at the laboratory participants provided their consent to participate. Once participants provided their consent, they were seated in front of a computer and a research assistant introduced the experiment. Participants were first asked to report the last time they ate and drank and how full they currently feel before completing the CRT and numeracy scale, followed by the Food Task, FCQ, DIET-SE, CDQ, and demographic questions. Participants completed all tasks and questionnaires within one experimental session that lasted 30 minutes or less.

Study 1 Results

Cognitive Measures. Numeracy scores averaged 75.4% accuracy (*SD* = 0.17), or 8.29/11 correct on average, and ranged from 18.2% to 100% correct. The numeracy measure also maintained acceptable reliability (α = .59). Participants took an average of 22.78 seconds (*SD* = 8.61) to answer each numeracy item. CRT scores averaged 23.6% accuracy (*SD* = 0.27), or 1.65/7 correct on average, and ranged from 0% to 100% correct. The CRT had strong reliability (α = .77), including the original item created by the author. Participants took an average of 35.26 seconds (*SD* = 17.56) to answer each CRT item.

Previous work observed a modest correlation ($r(62) = .29$, $p < .05$) between numeracy and CRT scores (Cokely & Kelley, 2009). Supporting hypothesis 1, a moderate positive correlation emerged between numeracy and CRT scores, $r(93) = .45$, $p < .01$. Furthermore, there was also a moderate positive correlation between CRT reaction time and numeracy reaction time, $r(93) = .63$, $p < .01$. It has been proposed that as individuals take longer on the CRT their performance accuracy increases. There were modest correlations observed between CRT reaction time and both CRT accuracy, $r(93) = .45$, $p < .01$, and numeracy accuracy, $r(93) = .30$, $p < .01$, supporting that individuals who take longer to answer the CRT problems generally perform better on both the CRT and numeracy measures.

Food Task Ratings. Individuals who perform more poorly on numeracy and CRT measures are typically more likely to succumb to decision biases, including the framing bias (Peters et al., 2006; Toplak et al., 2011). A stepwise multiple linear regression evaluated if numeracy scores, CRT scores, frames (unit or package), and/or dietary status predicted willingness to eat Food Task ratings. Full regression results are shown in Table 1 below. The type of frame and both CRT and numeracy scores were not found to be significant predictors of Food Task ratings. However, participants dietary status was a significant predictor of Food Task ratings, $B = -.59$, $t(93) = -2.01$, $p < .05$, and explained a significant proportion of the variance in ratings, $R^2 = .03$, $F(1, 93) = 4.04$, $p < .05$. The predictive nature of dietary status in this instance indicates those individuals currently dieting appeared to have lower ratings of the food scenarios. There was not a difference in Food Task ratings between package ($M = 4.04$, $SD = 1.19$) and unit frames ($M = 3.85$, $SD = 1.18$), though ratings appear to be slightly lower for the unit frame.

Mean ratings in the package frame by individual participants from ranged from 1.59 to 6.14, while mean ratings in the unit frame ranged from 1.55 to 6.18.

Table 1

Multiple Regression Analysis for Food Task Ratings

Variable	*B*	*SE B*	*β*	*t*	*p*
Dietary Status	-.59	.29	-.20	-2.01	.047*
	Adjusted R^2	.03			
	F	4.04			

Excluded Variables

Variable			*β*	*t*	*p*
Numeracy			.13	1.28	.204
CRT			-.02	-.23	.817
Frame			-.10	-.95	.344

*$p < .05$

An interesting pattern did emerge with the Food Task ratings when comparing the frames by differences in participants self-reported confidence to resist eating high calorie foods. An exploratory 2 (Frame) x 4 (DIET-SE High Calorie Confidence) ANOVA with Food Task ratings as the dependent variable revealed a significant main effect of DIET-SE high-caloric food confidence, $F(3,87) = 3.10$, $p < .05$, $\eta^2_p = 0.10$, though no significant interaction between frame and confidence, nor a main effect of frame. The mean Food Task ratings for the four levels of confidence in the package frame ranged from 3.73 – 4.21, while the range for the Food Task ratings in the unit frame ranged from 2.96 – 4.77.

Unit and package frames were also analyzed separately to examine simple effects using two one-way ANOVAs, with DIET-SE high-caloric food confidence levels as the independent variable and mean Food Task ratings as the dependent variable. DIET-SE high-caloric food confidence had a significant effect on Food Task ratings, though only in the unit frame, $F(3,44) = 4.57$, $p < .01$, $\eta^2 = 0.24$. Post hoc comparisons using the Tukey HSD test indicated those with the least confidence ($M = 4.77$, $SD = 0.86$) had significantly higher ratings than those with the most confidence ($M = 2.95$, $SD = 1.08$), $p < .01$. Therefore, it appears the unit frame Food Task ratings are driving this main effect of DIET-SE high-caloric food confidence noted earlier in the 2 (Frame) x 4 (DIET-SE High Calorie Confidence) ANOVA.

Furthermore, while not significantly different, when analyzing those with the least confidence in their ability to resist eating high calorie foods, participants in the unit frame had higher mean Food Task ratings ($M = 4.77$, $SD = 0.86$) than those in the package frame ($M = 4.21$, $SD = 1.49$). All of this suggests that those with the lowest confidence in their ability to resist eating high calorie foods, 19% of the sample in study 1, may be the most prone to demonstrate a framing preference based on the presentation of the calorie information.

Food Task Reaction Time. To obtain the total calories in the unit frame, I expected that individuals would have to take additional time to perform multiplication (Example: 5 cookies x 50 calories each = 250 calories) that those in the package frame would not have to do. An independent samples t-test confirmed that individuals in the unit frame (M = 3998.54ms, SD = 1533.99ms) took significantly longer to make their ratings than those in the package frame (M = 3408.36ms, SD = 1145.61ms), $t(93) = 2.12$, $p < .05$, supporting hypothesis 3. However, for those with the least confidence in their ability to resist eating high calorie foods, the opposite pattern emerged. Amongst only those participants with the lowest DIET-SE high-caloric food confidence, participants in the unit frame actually made their ratings more quickly on average (*M* = 3438.62ms, *SD* = 960.89ms) than those in the package frame (*M* = 4000.43ms, *SD* = 1833.94ms). While this difference was not significant, this unique pattern may still help explain why these same low confidence individuals had higher ratings in the unit than the package frame.

A stepwise multiple linear regression evaluated if numeracy scores, CRT scores, frames (unit or package), and/or dietary status predicted the amount of time participants took to make their Food Task ratings (henceforth known as Food Task reaction time). Frame was found to be a significant predictor of Food Task reaction time (Table 2), $B = 590.18$, $t(93) = 2.12$, $p < .05$, and accounted for a significant proportion of the variance in reaction time, $R^2 = .04$, $F(1, 93) = 4.50$, $p < .05$. This result confirms the aforementioned significant difference in reaction time based on frame, with those in the unit frame taking significantly longer to make their ratings, while also demonstrating a lack of influence of numeracy and CRT performance. However, when conducting separate regression analyses by frame, CRT scores were a significant predictor of Food Task reaction time only in the package frame (Table 3), $B = 1888.79$, $t(45) = 3.24$, $p < .01$, and accounted for a significant proportion of the variance in reaction time, $R^2 = .17$, $F(1, 45) = 10.46$, $p < .01$. This important finding indicates that improved performance on the CRT is associated with taking longer to decide, and potentially engaging in more cognitive reflection, while making dietary decisions. CRT scores, numeracy scores, and dietary status did not predict Food Task reaction time in the unit frame.

Table 2

Multiple Regression Analysis for Food Task Reaction Time

Variable	*B*	*SE B*	*β*	*t*	*p*
Frame	590.18	278.23	.22	2.12	.037*
	Adjusted R^2	.04			
	F	4.50			

Excluded Variables

Variable	*β*	*t*	*p*
Numeracy	.10	1.00	.327
CRT	.18	1.76	.082
Dietary Status	-.02	-.21	.831

*p <.05

Table 3

Multiple Regression Analysis for Food Task Reaction Time within Package Frame

Variable	*B*	*SE B*	*β*	*t*	*p*
CRT	1888.79	583.92	.43	3.24	.002*
	Adjusted R^2	.17			
	F	10.46			

Excluded Variables

Variable	*β*	*t*	*p*
Numeracy	.11	.72	.477
Dietary Status	.07	.52	.609

*p <.05

FCQ Convergence. Hypothesis 4 proposed sensory appeal and mood ratings from the FCQ would be significantly positively correlated with willingness to eat ratings, whereas health and weight control ratings would be significantly negatively correlated with willingness to eat ratings. As illustrated in Table 4, Food Task ratings correlated with ratings from a number of FCQ subscales. Since frame type was not a significant predictor of Food Task ratings, I collapsed across frames, and present the overall correlations in Table 4. Food Task ratings were modestly positively correlated with convenience and price ratings, and negatively correlated with health, natural content, and weight control ratings. This pattern of results indicates that those individuals that place more importance on health, eating natural foods, and controlling their weight had lower ratings in the Food Task. Additionally, those that placed greater value on price and convenience generally had higher ratings of the foods. With regards to Food Task reaction time, there were negative correlations between reaction time and mood, sensory appeal, and familiarity subscales. These correlations indicate that those that report placing more importance on their mood, the sensory appeal of the food, and their familiarity with the food generally responded faster to the Food Task scenarios.

Table 4

Correlations among FCQ subscales and Food Task ratings and reaction time(RT)

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Food Task Ratings	—										
2. Food Task RT	-.02	—									
3. FCQ - Health	**-.31****	-.11	—								
4. FCQ - Mood	.20	**-.34****	.17	—							
5. FCQ - Convenience	**.26****	-.02	-.16	.27**	—						
6. FCQ - Sensory Appeal	.17	**-.31****	.15	.40**	.28**	—					
7. FCQ - Natural Content	**-.39****	.03	.65**	-.06	.15	-.03	—				
8. FCQ - Price	**.20***	-.04	-.08	.15	.40**	.21*	-.20	—			
9. FCQ - Weight Control	**-.31****	-.01	.49**	-.04	.05	.01	.37**	.11	—		
10. FCQ - Familiarity	.01	**-.28****	-.05	.29**	.26*	.35**	-.08	.07	-.12	—	
11. FCQ - Ethical Concern	-.03	-.20	.33**	.30**	.04	.16	.34**	-.02	.06	.22*	—

**p <.05, ** p <.01*

Nutrition Facts Panels. One demographic question asked participants, "How often do you check Nutrition Facts panels on foods before purchasing or eating them?" 15% of participants indicated they never check panels, while 22% rarely do, 25% sometimes do, 30% often do, and 8% always check the panels. Interestingly, a modest negative correlation was found between this item and the Food Task ratings, $r(93) = -.27$, $p < .01$, and a positive correlation between this item and participants Food Task reaction time, $r(93) = .27$, $p < .01$. These correlations indicate that those that report they check Nutrition Facts panels more often had lower ratings in the Food Task and appeared to take more time when making their ratings.

DIET-SE. The DIET-SE asked participants to report their confidence in their ability to resist certain dietary temptations. As noted earlier, participants' confidence in their ability resist high calorie foods appears to impact Food Task ratings and reaction time, with those with the lowest level of confidence showing an increased vulnerability to frame type. Confirming hypothesis 5, and consistent with this influence of confidence, a moderate negative correlation was revealed between Food Task ratings and the high-caloric food subscale, $r(93) = -.43$, $p < .01$, indicating that those that rate the foods higher not surprisingly report a decreased confidence in their ability to resist eating high calorie foods. Additionally, a modest positive correlation was found between the high-caloric food subscale and participants dietary status, $r(93) = .22$, $p < .05$, demonstrating those dieting appeared to have increased confidence to resist high calorie foods. This increased confidence on behalf of the dieters appears to translate to dietary preferences, as the previously noted ability of dietary status to predict Food Task ratings demonstrates.

CDQ. I hypothesized participants currently dieting would have lower Food Task ratings. As previously noted, dietary status did predict Food Task ratings. Consistent with this finding, Food Task ratings and dietary status were found modestly negatively correlated, $r(93) = -.20$, $p <$

.05, suggesting those currently dieting generally had lower ratings than those who were not currently dieting.

Study 1 Discussion

As anticipated, cognitive reflection, or the ability to engage a deliberative system 2, was found to have a positive relationship with numeracy. Furthermore, the amount of time individuals take to respond to the CRT items was related not only to CRT performance, but also to numeracy performance. These findings again illustrate the predictive nature of the CRT task in measuring one's ability to engage in increased reflection and analysis before responding. Because of this predictive nature of the CRT and previous results demonstrating increased bias susceptibility on behalf of low CRT and low numeracy groups, I anticipated finding CRT and/or numeracy scores to be predictors of the Food Task ratings. Unfortunately, neither of these cognitive measures were found to be significant predictors of Food Task ratings. However, CRT performance was found to predict how long participants took to respond in the Food Task, though only for those participants in the package frame. Participants in the package frame who more accurately answered the CRT items appeared to engage in increased cognitive reflection not only in the CRT task itself, but also in the Food Task and numeracy measure. This finding further validates the use of the CRT as a measure of global cognitive reflection, which can influence decision making in additional tasks.

While CRT and numeracy scores were not predictors of preferences, exploratory analyses demonstrated that DIET-SE high-caloric food subscale ratings had an influence on Food Task ratings in two ways. First, when analyzing participants' Food Task ratings based on their high-caloric food confidence, an increased variability of Food Task ratings in the unit frame appeared in contrast with relative consistency in the package frame. Second, amongst those participants with the least confidence in their abilities to resist high calorie foods, those in the unit frame had higher, though not statistically significant, Food Task ratings than the package frame participants. In combination these findings suggest the unit frame presentation influences participants Food Task ratings in different ways based on their confidence to resist certain foods. For those with the least confidence, these results provide evidence that a per unit calorie presentation may elicit differences in preferences.

Additionally, I hypothesized that making ratings in the unit frame, where multiplication was required to obtain total calories, would take participants significantly longer than in the package frame. This hypothesis was confirmed. However, for participants with the least DIET-SE high-caloric food confidence, the opposite pattern emerged, as amongst these low confidence participants those in the unit frame actually made their ratings faster than those in the package frame. This hastened decision making may have contributed to the aforementioned differences in Food Task ratings, wherein those low in this confidence appear to make decisions more quickly and were more willing to eat the foods when the calorie information is presented in a per unit manner. Thus, there is reason to be concerned that a per unit calorie presentation can negatively influence those that already have the least confidence in resisting high calorie foods.

Results further demonstrated that participants who report more often using Nutrition Facts panels before purchasing or eating foods took more time to make their Food Task ratings and had lower ratings overall. These findings provide additional empirical evidence for the positive role these Nutrition Facts panels may play in consumer dietary decision making. However, further research is needed to fully understand how these panels may affect those with the least high-caloric food confidence, as evidence shows a trend of framing predispositions with these individuals. While this low confidence group was not anticipated to be susceptible to the framing manipulation, these individuals still represent a significant proportion of current and future consumers, thus finding ways to aid these consumers is a worthwhile endeavor.

Study 2 Rationale

Study 1 revealed that most participants check Nutrition Facts panels 'sometimes' or 'often' before making purchasing or dietary decisions. Those that reported using these panels more often also had lower ratings of the food scenarios. Furthermore, the presentation of calorie information in study 1 appeared to influence dietary decisions, wherein those with low confidence to resist eating high calorie foods appear to alter their preferences based on calorie presentation. Consequently, research investigating ways in which Nutrition Facts panels can be optimally framed or presented for effective understanding of dietary information is pertinent and necessary.

Previous research has shown those low in numeracy and cognitive reflection may be more susceptible to biases and poor decision making (Cokely & Kelley, 2009; Peters et al., 2006). Given the previously noted pervasiveness of obesity in America, as well as the risk factors and significant costs associated, interventions aimed at reducing obesity are warranted. One such intervention to combat obesity may target improving decision making and reducing susceptibility to biases. Researchers have offered ways to improve decision making and reduce bias susceptibility for low numeracy and low cognitive reflection groups previously (Milkman et al., 2009; Peters, 2012; Reyna & Brainerd, 2008). For example, Peters (2012) has offered three suggestions to reduce the negative impact of numeracy on decision outcomes and minimize the difference between low and high numerate individuals. Included in these suggestions is the recommendation that numeric information be supplemented with visual representations. Including pie charts, bar graphs and other graphic displays that allow groups to better understand part-whole relations, these visual representations have been found to aid understanding of numeric information among less numerate groups (Garcia-Retamero & Galesic, 2009). In light of the benefit that visual displays appear to offer, study 2 further examined the potential benefit that graphic displays may have for those low in numeracy and cognitive reflection through an additional analysis of the framing bias in conjunction with numeracy and dual process theories.

Presenting numeric information in the form of pie charts has been shown to be an effective way to elicit accurate assessments of part-whole relationships (Ancker, Senathirajah, Kukafka, & Starren, 2006). In the Food Task in study 2, percentages, expressed as numeric values (Ex: 10%), were compared with pie chart displays of the same information to examine effects of framing once more. Furthermore, study 2 began to evaluate the efficacy of using pie chart displays as a possible decision making intervention (See Appendix A for an illustration). The influence of numeracy and dual process theories were assessed to determine if those lower in numeracy and/or cognitive reflection show increased susceptibility to framing in this instance. Further, study 2 examined whether pie chart displays may offer a benefit to those low in DIET-SE high-caloric confidence, who appeared more susceptible to preference differences due to framing in study 1.

In study 2, numeric percentages of food scenarios were created based on how the calories in a specific amount of a food constitute a given percent of a daily diet of 2,000 calories, as proposed by the FDA. Though Nutrition Facts panels do not currently show the percentage of daily calories in a serving of a food, the panels do show percentages for many other nutritional categories including fat, sodium, and carbohydrate content, to name a few. One might expect that results obtained using calories could be demonstrated using any of the other nutritional categories. However, for simplicity sake, and in conjunction with study 1, study 2 again used calories for participants to base their ratings.

Study 2 Hypotheses

***Hypothesis 1*:** I hypothesized that numeracy and CRT performance would be modestly correlated once more.

***Hypothesis 2*:** I hypothesized that numeracy scores, CRT scores, and frame (numeric or pie chart) would be predictor variables of Food Task ratings.

It has been proposed that visual representations may help those that are less numerate better understand numbers and quantities (Peters, 2012). If indeed graphic representations aid the less numerate in making more accurate assessments, results should demonstrate that numeracy is not a significant predictor of the pie chart presentation frame ratings, whereas numeracy should predict numeric frame ratings.

***Hypothesis 3*:** Numeracy should be a predictor of Food Task ratings in the numeric frame. Numeracy should not be a predictor of ratings in the pie chart frame.

Hypothesis 4: I hypothesized that sensory appeal and mood subscale ratings of the FCQ would be positively correlated with Food Task ratings, while health and weight control ratings would be negatively correlated with Food Task ratings.

***Hypothesis 5*:** Consistent with study 1, I again hypothesized that high-caloric food confidence ratings from the DIET-SE would be negatively correlated with Food Task ratings.

Hypothesis 6: Given dietary status was a predictor of Food Task ratings in study 1, I hypothesized those currently dieting would have lower Food Task ratings once more, as represented by a negative correlation between CDQ scores and ratings.

Study 2 Method

Participants

One hundred Auburn University undergraduate students participated in study 2. Participants were recruited through Auburn University's Psychology Department SONA Systems and compensated with extra credit. To achieve an equal or greater effect size ($\eta^2 = .11$) that was found in Peters et al. (2006), greater than sixty-six participants completed study 2. Participants were ineligible to complete study 2 if they completed study 1. Two participants were removed from analyses because their Food Task ratings were greater than two standard deviations from the mean. Hence, the analyses are based on 98 participants (13 males, 85 females). 50% of the sample was 18 years old, 29% were 19 years old, 13% were 20 years old, 3% were 21 years old, and 5% were 22 years old or older. Fifty participants were randomly assigned to the chart frame, while forty-eight were randomly assigned to the numeric frame.

Design

Multiple linear regressions were used in study 2. Numeracy scores, CRT scores, and frames (numeric or pie chart) were evaluated for their ability to predict willingness to eat ratings and reaction time when making ratings. Type of frame was treated as a between-subjects variable, whereas all participants completed the same numeracy and CRT measures. Additional ANOVA analyses examined whether interactions or main effects were present between DIET-SE ratings and frames, with willingness to eat ratings and reaction time as dependent variables. Pearson correlation analyses investigated whether ratings were correlated with subscales of the FCQ, DIET-SE, and CDQ.

Materials

Study 2 utilized the same CRT, numeracy scale, FCQ, DIET-SE, CDQ, and demographic questions utilized in study 1. The effect of framing was investigated using a variation of the Food Task.

Food Task

The Food Task in study 2 operated similar to the Food Task utilized in study 1, with participants rating their willingness to eat various foods. In this variation, participants were provided food scenarios in conjunction with a numeric percentage number or a pie chart representation of the same percentage. These percentages represented what percent of the recommended 2,000 calories a day the food scenario specifies. For example, participants in the numeric frame were asked to indicate their willingness to eat 4 waffles, given that this would amount to 20% of their Daily Value calorie recommendation. Those in the pie chart frame saw a pie chart with 20% of the pie shaded with no numbers present. Participants rated their willingness to eat the foods on scales from 1(very unwilling) to 7(very willing). Additionally, images of the foods were presented when participants were providing their ratings. Participants provided ratings for 32 scenarios, including entrees, snacks, fruits, and vegetables. However, fruits and vegetables were again excluded from analyses due to their low caloric nature (Example: 3 carrots amounting to 5%), which left 22 scenarios for analysis. Participant instructions and sample stimuli are included in Appendix A.

Procedure

Upon arrival at the laboratory participants provided their consent to participate. Once participants provided their consent, they were seated in front of a computer and a research assistant introduced the experiment. Participants were first asked to report the last time they ate and drank and how full they currently feel before completing the CRT and numeracy scale, followed by the Food Task, FCQ, DIET-SE, CDQ, and demographic questions. Participants completed all tasks and questionnaires within one experimental session that lasted 30 minutes or less.

Study 2 Results

Cognitive Measures. Numeracy scores averaged 75.7% accuracy (*SD* = 0.20), or 8.32/11 correct on average, and ranged from 9% to 100% correct. The numeracy measure also maintained strong reliability (α = .76). Participants took an average of 21.27 seconds (*SD* = 6.94) to answer each numeracy item. CRT scores averaged 18.7% accuracy (*SD* = 0.23), or 1.31/7 correct, and ranged from 0% to 86% correct. The CRT also had strong reliability (α = .74), including the original item created by the author. Participants took an average of 34.30 seconds (*SD* = 26.20) to answer each CRT item.

Study 1 observed a modest correlation between numeracy and CRT scores, $r(93) = .45$, $p < .05$, which confirmed previous findings demonstrating a positive correlation between these measures (Cokely & Kelley, 2009). As expected, Study 2 again confirms this finding and hypothesis 1, as numeracy and CRT scores were again found to be modestly correlated, $r(96) = .38$, $p < .01$. Replicating the pattern from study 1, there was also a moderate positive correlation between numeracy reaction time and CRT reaction time, $r(96) = .38$, $p < .01$. Finally, once again, those that took longer to complete the CRT appeared to have increased performance accuracy on the CRT, $r(96) = .26$, $p < .01$.

Food Task Ratings. I anticipated that Food Task ratings would be predicted by numeracy scores, CRT scores, and frame type. Unfortunately, none of these anticipated predictors, nor dietary status, significantly predicted Food Task ratings. Additionally, I hypothesized numeracy would be a predictor of ratings for participants in the numeric frame, but not the pie chart frame. Numeracy was not found to be a predictor of ratings for either frame. No significant difference in Food Task ratings between numeric (*M* = 3.83, *SD* = 0.83) and pie chart frames (*M* = 3.84, *SD* = 0.94) was observed. As a reminder, in study 1 there was not a difference in Food Task ratings between package (*M* = 4.04, *SD* = 1.19) and unit frames (*M* = 3.85, *SD* = 1.18). As the same food scenarios were used in studies 1 and 2, comparisons may be made between the ratings in studies 1 and 2, however no significant difference was observed between ratings when comparing the two studies. Mean ratings in the numeric frame by individual participants from ranged from 2.41 to 5.95, while mean ratings in the pie chart frame ranged from 2.00 to 5.73.

As those with low DIET-SE high-caloric food confidence appeared to demonstrate framing preferences in study 1, this subscale was again examined in study 2. A 2 (Frame) x 4 (DIET-SE High Calorie Confidence) ANOVA with Food Task ratings as the dependent variable was utilized in study 2, however there was not a main effect of confidence or frame, nor a significant interaction, *p*'s > .05. Notwithstanding, Food Task ratings for the four levels of confidence in the pie chart frame ranged from 3.51 – 4.21, while the numeric frame ratings ranged from a 3.65 – 3.95. In comparing the frames for those with the least confidence, Food Task ratings in the pie chart frame actually appear to be higher than ratings in the numeric frame. Means and standard deviations by frames are presented in Table 5. When analyzing the numeric and pie chart frames separately to examine simple effects using two one-way ANOVAs, with DIET-SE high-caloric food confidence levels as the independent variable and mean Food Task ratings as the dependent variable, DIET-SE high-caloric food confidence nearly had a significant effect on Food Task ratings, though only in the pie chart frame, $F(3,46) = 2.26$, $p = 0.94$, $\eta^2 = 0.13$.

Table 5

Means and standard deviations of Food Task ratings presented by Frame and DIET-SE High-Caloric Food Confidence

Frame	DIET-SE High-Caloric Food Confidence	Mean	SD	N
Pie chart	Not at all confident	4.21	0.97	11
	A little confident	4.17	0.71	13
	Moderately confident	3.51	0.95	17
	Very confident	3.53	0.99	9
	Subtotal	3.84	0.94	50
Numeric	Not at all confident	3.73	0.79	3
	A little confident	3.79	0.79	21
	Moderately confident	3.95	0.97	19
	Very confident	3.64	0.61	5
	Subtotal	3.83	0.83	48

Food Task Reaction Time. While numeracy and CRT scores were not significant predictors of Food Task ratings, CRT scores were predictive of Food Task reaction time (Table 6), $B = 1134.46$, $t(96) = 2.10$, $p < .05$, and explained a significant proportion of the variance in Food Task reaction time, $R^2 = .03$, $F(1, 96) = 4.41$, $p < .05$. This predictive model indicates that those that answered the CRT items more accurately appeared to take longer to make their Food Task ratings, presumably indicative of engaging in increased cognitive reflection. This finding replicates the predictive nature of CRT performance that was only observed for the package frame in study 1.

Table 6

Multiple Regression Analysis for Food Task Reaction Time

Variable	*B*	*SE B*	*β*	*t*	*p*
CRT	1134.46	540.40	.21	2.10	.038*
	Adjusted R^2	.03			
	F	4.41			

Excluded Variables

Variable	*β*	*t*	*p*
Numeracy	.09	.81	.423
Frame	-.01	-.13	.894
Dietary Status	.02	.17	.863

*$p < .05$

When analyzing the influence of numeracy and CRT scores on Food Task reaction time with separate regression analyses for each frame, CRT scores is found to be a predictor of Food Task reaction time, though only in the numeric frame (Table 7), *B* = 2607.74, *t*(46) = 3.83, $p < .01$. Further, the CRT performance also explains a significant proportion of the variance in Food Task reaction time within this frame, $R^2 = .23$, $F(1, 46) = 14.64$, $p < .01$. Therefore, it appears as though increased CRT performance predicting Food Task reaction time is driven by increased cognitive reflection occurring within the numeric frame only. It should be noted there was not a difference in Food Task reaction time between numeric (*M* = 3539.50ms, *SD* = 1111.38ms) and pie chart frames (*M* = 3676.06ms, *SD* = 1384.88ms), though those in the pie chart appear to take slightly longer.

Table 7

Multiple Regression Analysis for Food Task Reaction Time within Numeric Frame

Variable	*B*	*SE B*	*β*	*t*	*p*
CRT	2607.74	681.58	.49	3.83	<.001*
	Adjusted R^2	.23			
	F	14.64			

Excluded Variables

Variable	*β*	*t*	*p*
Numeracy	.04	.30	.769
Dietary Status	.18	1.36	.181

*$p < .01$

While DIET-SE high-caloric food confidence did not have a significant influence on food ratings, this subscale did appear to influence Food Task reaction time. A 2 (Frame) x 4 (DIET-SE High Calorie Confidence) ANOVA with Food Task reaction time as the dependent variable revealed a significant main effect of DIET-SE high-caloric food confidence, $F(3,90) = 3.11$, $p < .05$, $\eta^2_p = 0.09$, though no significant interaction between frame and confidence, nor a main effect of frame. Further, Food Task reaction time was correlated with DIET-SE high-caloric food confidence, $r(96) = -.26$, $p < .05$. These results demonstrate that individuals with reduced confidence appear to take longer to make their Food Task ratings.

FCQ Convergence. In this sample, the FCQ was reliable (α = .86) with a mean of 2.58 (*SD* = 0.37) where mean scores ranged from 1.64 to 3.61. Additionally, the scores for each factor are as follows: Health (*M* = 2.88, *SD* = 0.67, α = .86), Mood (*M* = 2.44, *SD* = 0.68, α = .81), Convenience (*M* = 2.93, *SD* = 0.62, α = .82), Sensory Appeal (*M* = 2.83, *SD* = 0.63, α =

.69), Natural Content (*M* = 2.24, *SD* = 0.78, α = .83), Price (*M* = 3.07, *SD* = 0.76, α = .84), Weight Control (*M* = 2.64, *SD* = 0.83, α = .83), Familiarity (*M* = 2.14, *SD* = 0.66, α = .70), and Ethical Concern (*M* = 1.57, *SD* = 0.63, α = .66).

I hypothesized that sensory appeal and mood ratings from the FCQ would be significantly positively correlated with Food Task ratings, whereas health and weight control ratings would be significantly negatively correlated with Food Task ratings. Table 8 summarizes the modest correlations between ratings for subscales from the FCQ and both Food Task ratings and Food Task reaction time. Since frame type was not a significant predictor of Food Task ratings, I collapsed across frames, and present the overall correlations in Table 8. Consistent with study 1, Food Task ratings were significantly positively correlated with price and convenience ratings, while negatively correlated with natural content and weight control ratings. Consequently, those that place more importance on price and convenience appeared to have higher ratings of the foods, whereas those that place more importance on eating natural foods and controlling their weight generally had lower ratings of the foods.

Table 8

Correlations among FCQ subscales and Food Task ratings and reaction time(RT)

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Food Task Ratings	—										
2. Food Task RT	.19	—									
3. FCQ - Health	-.19	-.01	—								
4. FCQ - Mood	-.03	-.14	.21*	—							
5. FCQ - Convenience	**.25***	.13	.04	.32**	—						
6. FCQ - Sensory Appeal	.04	.04	-.16	.46**	.32**	—					
7. FCQ - Natural Content	**-.39****	-.07	.67**	.11	-.15	-.14	—				
8. FCQ - Price	**.44****	.04	.05	.40**	.52**	.27**	-.16	—			
9. FCQ - Weight Control	**-.41****	-.02	.59**	.20*	-.16	-.02	.51**	-.14	—		
10. FCQ - Familiar	.10	-.09	-.12	.20	.20	.45**	-.12	.17	-.10	—	
11. FCQ - Ethical Concern	.01	-.09	.25*	.36**	.12	.22*	.40**	.23*	.10	.09	—

**p <.05, ** p <.01*

Nutrition Facts Panels. Just as in study 1, participants were asked, "How often do you check Nutrition Facts panels on foods before purchasing or eating them?" 9% of participants indicated they never check panels, while 22% rarely do, 27% sometimes do, 25% often do, and 17% always check the panels. Again, a modest negative correlation was found between this item and the Food Task ratings, $r(96) = -.29$, $p < .01$. This correlation demonstrates that those that check food panels more often generally had lower ratings in the Food Task. Additionally, a modest positive correlation was also revealed between this item and CDQ scores, $r(96) = .38$, $p < .01$, which indicates those that are currently dieting likely see a benefit to these panels in making their dietary selections.

CDQ. CDQ scores ranged from 1 to 2, with a mean of 1.52 ($SD = 0.40$). CDQ scores were hypothesized to negatively correlate with Food Task ratings. CDQ scores were not found to correlate with Food Task ratings, however they were correlated with checking Nutrition Facts panels as previously noted.

DIET-SE. In study 2, the DIET-SE again had strong reliability ($\alpha = .80$), with a mean of 2.06 ($SD = 0.73$), where mean scores ranged from 0.27 to 3.82. The scores for each factor are as follows: High-Caloric Food ($M = 1.92$, $SD = 0.93$, $\alpha = .69$), Social and Internal Factors ($M = 1.97$, $SD = 0.87$, $\alpha = .65$), and Negative Emotional Events ($M = 2.38$, $SD = 1.03$, $\alpha = .72$).

A modest negative correlation between Food Task ratings and the DIET-SE social and internal factors subscale, $r(96) = -.33$, $p < .01$ was observed. This negative correlation indicates that those that rated the Food Task scenarios higher generally reported a decreased confidence in their ability to resist social and internal factors regarding eating behavior. Additionally, Food Task reaction time was also modestly negatively correlated with the high-caloric food subscale, *r*(96) = -.26, $p < .01$, confirming hypothesis 5 and demonstrating that participants with decreased high-caloric food confidence appear to take longer to make their Food Task ratings.

Study 2 Discussion

Consistent with results from study 1, a relationship between CRT and numeracy was again observed, as well as a relationship between CRT reaction time and CRT accuracy. The CRT appears to be a measure that can continue to be used to measure cognitive reflection. Given previous results showing that the CRT and numeracy measures predict susceptibility to framing, I again anticipated CRT and/or numeracy performance would predict Food Task ratings. Unfortunately, the results do not support this hypothesis.

Similar to study 1, there appears to be a relationship between CRT performance and Food Task reaction time. A linear regression model found that CRT scores predicted Food Task reaction time. However, separate analyses by frame revealed CRT scores predicted Food Task reaction time only in the numeric frame, thus it appears the numeric frame is driving this overall predictive model. Once again these findings provide validation of the CRT as a measure capable of predicting increased cognitive reflection, which can occur in tasks other than the CRT. This increased cognitive reflection may have implications for a wide range of real world decisions, such as with increased dietary preference reflection seen here.

Additionally, an influence of DIET-SE high-caloric food confidence is again observed in study 2. It appears as though those participants with less confidence appear to take more time to make their Food Task ratings. Thus, it appears that using a percentage for calories, whether it be as a numeric value or a pie chart, may at least promote increased reflection in low confident individuals. Future research would be well-served by attempting to find additional ways nudge these low confidence consumers to take longer to make decisions and attempt to engage their deliberative system 2 to provide additional decision making forethought before acting.

Consistent with findings from study 1, a modest relationship was observed between how often participants report checking Nutrition Facts panels and Food Task ratings. Additionally, those currently dieting were also found more likely to use Nutrition Facts panels before making dietary selections. These findings appear to: 1) indicate that those that are currently dieting are more likely to use these Nutrition Facts Panels to assist their food decision making and 2) presents compelling evidence for the importance of examining how these Nutrition Facts panels may be improved to better aid all consumers in making dietary selections.

General Discussion

The current studies sought to better understand how the presentation of nutrition information influences food preferences. The impact of cognitive and decision making variables, including numeracy and cognitive reflection, were also investigated in relation to one another and with regards to food preferences. Results of the current studies further illustrate a positive relationship between cognitive reflection and numeracy. This relationship has the potential to influence how susceptible individuals are to biases. Previous results have shown participants low in numeracy or cognitive reflection appear to show a larger framing bias, in which average responses between frames differ more greatly for these participants compared to those who more accurately answer the numeracy or CRT items (Cokely & Kelly, 2009; Oechssler et al., 2009; Peters et al., 2006; Toplak et al., 2011).

Unfortunately, results from the present studies do not provide additional support for the notion of increased susceptibility to the framing bias by low numeracy and low CRT groups. Neither the CRT, nor the numeracy measure was predictive of Food Task ratings in the current studies, demonstrating that low numeracy and CRT participants were no more prone to the framing bias in these instances. However, CRT performance was found predictive of Food Task reaction time in package and numeric frames within respective studies 1 and 2. Participants performing better on the CRT appear to take more time to make decisions in the food preference domain. Future studies should continue to investigate how CRT performance can predict increased reflection in other decision making domains. As increased cognitive reflection has also been shown to benefit CRT performance in the current studies, it stands to reason that increased reflection should also benefit performance or alter preferences in other areas as well, perhaps even helping individuals to make more thoughtful health decisions.

It was also anticipated that type of frame would be predictive of Food Task ratings, which would demonstrate the presence of a calorie presentation framing bias. However, in both studies, type of frame was not found to be predictive of food ratings. Thus, it would appear as though the respective Food Tasks did not adequately produce a strong framing bias. As numeracy and CRT measures predict increased susceptibility to the framing bias, it is therefore not surprising that these measures did not predict Food Task ratings, given the lack of an overall framing bias. However, in study 1, one group of participants did appear to show signs of preference changes due to framing. Those participants with the least confidence in their abilities to resist eating high calorie foods appeared prone to differences in both preferences and time to respond as a result of framing. This is an indication of the presence of a Food Task framing bias when using a predictive measure, DIET-SE, that is within the same health domain as the framing bias task. Notwithstanding, the influence of cognitive reflection and numeracy on dietary behavior has certainly not been ruled out, but arguably was not adequately captured in the current studies. Future research should continue to investigate the presence of framing biases in the health domain, including areas such as dietary selections and medical decision making. Framing biases in this domain have the potential for significant negative health outcomes, with associated monumental costs. The influence of cognitive reflection and numeracy should also be further examined to better understand and identify population groups that may be at an increased risk of framing, such that efforts can begin to target improving these groups decision making more specifically.

The Food Tasks used in the current studies appear to have a limited ability to produce framing biases. However, results from these tasks still provide valuable information regarding dietary selections. For instance, convergence between the Food Task ratings and self-report measures such as the FCQ and DIET-SE was found. In both studies, negative relationships were observed between Food Task ratings and both the natural content and weight control factors of the FCQ, suggesting individuals who care less about these factors have an increased willingness to eat foods with high caloric content. Additionally, price and convenience factor ratings from the FCQ were found to be positively correlated with Food Task ratings. Though these correlations may be an artifact of college students trying to get the most food for their money in the most convenient means possible by maximizing the calorie content in their foods, this nonetheless provides meaningful information about influences of dietary selections for current and future consumers. For instance, understanding the importance of factors like price and convenience in dietary decision making may allow researchers or practitioners to specifically orient their healthy eating programs to target these factors more directly.

Additional convergence was observed between DIET-SE high-caloric food confidence and both Food Task ratings and reaction time. Participants with the least confidence in their ability to resist high calorie foods appear to have higher Food Task ratings and/or take longer to make their ratings. In sum, the convergence demonstrated between the Food Task ratings and self-report measures further validate the use of these measures in predicting consumers eating behaviors. This convergence also improves our understanding of how these factors manifest themselves in the dietary selection process.

Significant relationships were also observed between dieting, Food Task ratings, and the use of Nutrition Facts panels. For example, current dieters were found more likely to have lower Food Task ratings in study 1, demonstrating an association between intent to diet and a willingness to eat particular foods. In both studies 1 and 2 participants that reported more often using Nutrition Facts panels before making selections were found more likely to have lower Food Task ratings. Lastly, in study 2 a positive relationship emerged between using Nutrition Facts panels and current dieting status. In combination these relationships highlight the value these panels have in potentially aiding or hindering the dietary selection process. Furthermore, these findings demonstrate how Nutrition Facts panels may be used as a gateway towards helping dieters and non-dieters alike to make more informed dietary selections. The importance of these panels is evident, however, for these panels to have the most value and benefit for consumers, future studies should continue to investigate and seek to find ways to better present nutrition information to aid all consumers. Research such as Helfer and Shultz (2014), Newman, Howlett, and Burton (2014) and Roberto et al. (2012) are prime examples to follow moving forward.

Limitations

There are a few notable limitations to the current studies that warrant additional remarks. One such limitation of these studies has already been mentioned, that of the lack of framing bias that the Food Tasks appeared to create. If the Food Tasks had produced an overall framing bias, one could make stronger conclusions regarding the influence of cognitive reflection and numeracy with regard to the interpretation and understanding of calorie information. However, since the Food Tasks did not adequately produce a framing bias, arguments in support or in opposition of the influence of cognitive reflection and numeracy in this health domain remain unanswerable in the context of the current studies.

Additionally, the sample restriction to college-aged students (more than 50% of the participants were under 19 years of age) is another limitation in the current studies. This sample restriction limits the interpretation of these results as being indicative of eating behavior and preferences of the U.S. population as a whole. Future studies would benefit from the inclusion of a wider variety of ages, as well as socioeconomic levels and ethnicities, to capture a more complete understanding eating behavior in the U.S.

Finally, arguments have been presented for the role that Nutrition Facts panels play in dietary decision making. However, only one demographic question directly assessed the use of these panels in making dietary selections. Future studies should seek to obtain a more comprehensive view of the use of these panels through a multi-item scale investigating how often and under what conditions individuals typically read the Nutrition Facts panels. Doing so would provide researchers stronger evidence for the influence these panels can have in the dietary selection process and allow for more specific analyses concerning how individuals use and interpret these panels. With increased understanding of how these panels are presently being used, more specific targeted interventions could be developed and examined.

Conclusions

In the current studies, the influence of cognitive reflection and numeracy was explored in the health domain of eating behavior in order to assess if these cognitive measures predict increased susceptibility to the presentation of calorie information. In both studies 1 and 2, a Food Task was used, wherein calorie information was presented in alternative ways, with the expectation of a framing bias occurring based on presentation format. Results demonstrated the ability of the CRT to predict the amount of time individuals will take to make food ratings, though not the food ratings themselves. However, this predictive nature of the CRT was limited to specific frames within each study. Aforementioned limitations of the Food Task notwithstanding, the CRT appears to be a domain-general cognitive measure that can be used to predict reaction time, and potentially performance or preferences, in a wide variety of decision making tasks. Unfortunately, the role these measures may have with regards to dietary decision making has not been fully understood through the current studies. Future studies should continue to investigate the ability of CRT and numeracy measures to predict dietary decision making, as well as the impact these measures may have across a multitude of additional health decision making domains.

The current studies also demonstrated convergence between food ratings and self-reported eating behavior, measured through the FCQ, DIET-SE, and CDQ measures, providing evidence for the use of these measures as indicators of actual eating preferences. Furthermore, the use of Nutrition Facts panels was investigated and appears to demonstrate a usability of these panels to inform consumers and alter eating behavior. Future research should continue to investigate how Nutrition Facts panels can more plainly represent dietary information, such that no individual or group faces additional challenges in reading and understanding the panels. While low numeracy and low CRT groups did not differ in their Food Task ratings, their propensity to be challenged by interpreting a Nutrition Facts panel is not ruled out. Furthermore, ways in which packaged foods may more visibly indicate the dietary information where consumers may be more likely to see and/or use the information may be beneficial. Perhaps this includes making calories larger, as recently proposed by the FDA, or putting limited dietary information on the front, as well as the back of packaging, in order to aid a wider range of consumers. Given that a majority of participants in these studies report at least sometimes checking these panels before making dietary decisions, the results of the current studies suggest that improving the transmission of this nutrition information to consumers would have a positive effect on the obesity epidemic in the U.S.

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Appendix A

Initial Instructions: All Participants
Thank you for agreeing to participate in the experiment. In this experiment, you will be asked to complete several tasks and then answer questions about your experience with the tasks. We will also ask you to complete several surveys. Please read the instructions carefully for each task and each survey. We will provide detailed instructions throughout the experiment on the screen. Please feel free to ask any questions during the experiment.

Food Task (Study 1):

Unit Condition:
Instructions:
In the following task you will see various foods. Please rate how willing you are to eat the amount of the food shown and described in one sitting. In the example provided, you are asked how willing are you to eat 5 cookies if each cookie contains 50 calories.

Example:

How willing are you to eat

5 cookies
50 calories each

1 (very unwilling) 2 3 4 5 6 7 (very willing)

Package Condition:
Instructions:
In the following task you will see various foods. Please rate how willing you are to eat the amount of the food shown and described in one sitting. In the example provided, you are asked how willing are you to eat 5 cookies if this is a total of 250 calories.

Example:

How willing are you to eat

5 cookies
250 calories total

1 (very unwilling) 2 3 4 5 6 7 (very willing)

<u>Food Task (Study 2):</u>

Numeric condition:

Instructions:
In the following task you will see various foods. Please rate how willing you are to eat the amount of the food shown and described in one sitting. In the example provided, you are asked how willing are you to eat 3 brownies if they contain 15% of your daily calorie recommendation of 2,000 calories.

Example:

How willing are you to eat

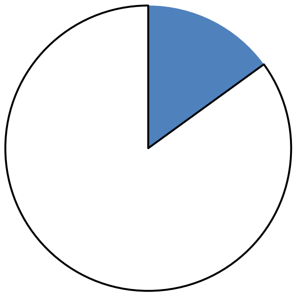
3 brownies
15%

1 (very unwilling)   2   3   4   5   6   7 (very willing)

Pie Chart condition:

Instructions:
In the following task you will see various foods. Please rate how willing you are to eat the amount of the food shown and described in one sitting. In the example provided, you are asked how willing are you to eat 3 brownies if they contain 15% of your daily calorie recommendation of 2,000 calories. This 15% is shown shaded in the pie chart to the right.

Example:



How willing are you to eat

3 brownies

1 (very unwilling)   2   3   4   5   6   7 (very willing)

<u>Cognitive Reflection Test</u>

A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost? [Intuitive Answer: $0.10; Correct Answer: $0.05]

If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? [Intuitive Answer: 100 minutes; Correct Answer: 5 minutes]

In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? [Intuitive Answer: 24; Correct Answer: 47]

If John can drink one barrel of water in 6 days, and Mary can drink one barrel of water in 12 days, how long would it take them to drink one barrel of water together? [Intuitive Answer: 9; Correct Answer: 4]

Jerry received both the 15th highest and the 15th lowest mark in the class. How many students are in the class? [Intuitive Answer: 30; Correct Answer: 29]

A man buys a pig for $60, sells it for $70, buys it back for $80, and sells it finally for $90. How much has he made? [Intuitive Answer: $10; Correct Answer: $20]

A soccer team made 325 passes in their recent game. The forward and midfielder players made 225 more passes than the defensive players. How many passes did the defensive players make? [Intuitive Answer: 100; Correct Answer: 50]

Numeracy Task

Imagine that we roll a fair, six-sided die, 1,000 times. Out of 1,000 rolls, how many times do you think the die would come up even (2, 4, or 6)?

In the BIG BUCKS LOTTERY, the chances of winning a $10.00 prize are 1%. What is your best guess about how many people would win a $10.00 prize if 1,000 people each buy a single ticket from BIG BUCKS?

In the ACME PUBLISHING SWEEPSTAKES, the chance of winning a car is 1 in 1,000. What percent of tickets of ACME PUBLISHING SWEEPSTAKES win a car?

If Person A's risk of getting a disease is 1% in ten years, and Person B's risk is double that of A's, what is B's risk?

If Person A's chance of getting a disease is 1 in 100 in ten years, and Person B's risk is double that of A, what is B's risk?

If the chance of getting a disease is 10%, how many people would be expected to get the disease out of 100?

If the chance of getting a disease is 10%, how many people would be expected to get the disease out of 1000?

If the chance of getting a disease is 20 out of 100, this would be the same as having ____% chance of getting the disease?

The chance of getting a viral infection is .0005 out of 10,000 people, about how many of them are expected to get infected?

Which of the following numbers represents the biggest risk of getting a disease? 1 in 100, 1 in 1000, 1 in 10

Which of the following represents the biggest risk of getting a disease? 1%, 10%, 5%

Food Choice Questionnaire

For each item indicate the degree to which you agree with the following statements using the following scale:
1 = not important at all, 2 = a little important, 3 = moderately important, and 4 = very important

Is it important to me that the food I eat on a typical day…

Is easy to prepare
Contains no additives
Is low in calories
Tastes good
Contains natural ingredients
Is not expensive
Is low in fat
Is familiar
Is high in fiber and roughage
Is nutritious
Is easily available in shops and supermarkets
Is good value for the money
Cheers me up
Smells good
Can be cooked very simply
Helps me cope with stress
Helps me control my weight
Has a pleasant texture
Is packaged in an environmentally friendly way
Comes from countries I approve of politically
Is like the food I ate when I was a child
Contains a lot of vitamins and minerals
Contains no artificial ingredients
Keeps me awake/alert
Looks nice
Is high in protein
Takes no time to prepare
Keeps me healthy
Is good for my skin/teeth/hair/nails etc.
Makes me feel good
Has the country of origin clearly marked
Is what I usually eat
Helps me cope with life
Can be bought in shops close to where I live or work
Is cheap

Current Dieting Questionnaire

I am trying to lose weight by eating less
1 = true, 2 = false

I choose foods that are low in fat because I am trying to lose weight
1 = true, 2 = false

Are you now watching what you eat in order to lose weight?
1 = yes, 2 = no

<u>Dieter's Inventory of Eating Temptations – Self-Efficacy</u>

Please imagine yourself in each of the following situations and rate how confident you are that you could overcome them, using the 5-point scale below.

0 = not at all confident, 1 = a little confident, 2 = moderately confident, 3 = quite confident, 4 = very confident

You are having dinner with your family and your favorite meal has been prepared. You finish the first helping and someone says, "Why don't you have some more?" How confident are you that you would turn down a second helping?

You often overeat at supper because you are tired and hungry when you get home. How confident are you that you would not overeat at supper?

There is a party at work for a coworker and someone offers you a piece of cake. How confident are you that you would turn it down?

You just had an upsetting argument with a family member. You are standing in front of the refrigerator and you feel like eating everything in sight. How confident are you that you would find some other way to make yourself feel better?

You are invited to someone's house for dinner and your host is an excellent cook. You often overeat because the food tastes so good. How confident are you that you would not overeat as a dinner guest?

You finished your meal and you still feel hungry. There are cakes and fruits available. How confident are you that you would choose the fruits?

You are at a friend's house and your friend offers you a delicious looking pastry. How confident are you that you would refuse this offer?

You are having a hard day at work and you are anxious and upset. You feel like getting a candy bar. How confident are you that you would find a more constructive way to calm down and cope with your feelings?

You feel like celebrating. You are going out with friends to a good restaurant. How confident are you that you would celebrate without overeating?

You are out with a friend at lunch time and your friend suggests that you stop and get some ice cream. How confident are you that you would resist the temptation?

You just had an argument with your boyfriend or girlfriend. You are upset, angry, and you feel like eating something. How confident are you that you would talk the situation over with someone or go for a walk instead of eating?

Demographic Questionnaire

Please enter your age: ____

Please indicate your gender:
___Female ___Male ___Other

Please indicate your current status at Auburn University:
___Freshman ___ Sophomore ___ Junior ___ Senior

Please enter your height ________ inches

Please enter your weight ________ pounds

How many calories do you eat in a typical day?________

Please indicate your place of residence:
_____Off campus _____On campus

How often do you eat on campus?
1 time per week 2 times per week 3 times per week 4 times per week 5+ times per week Never

How often do you check Nutrition Facts panels on foods before purchasing or eating items?
Never Rarely Sometimes Often Always

How many minutes do you exercise in an average week?

Are you currently on a diet? If yes, please describe what kind of diet_____________

Do you have any food allergies? If yes, please describe ______________

Do you have any dietary restrictions (examples: vegetarian, vegan, gluten)? If yes, what restriction?______

How long has it been since you last ate?
1 hour 2 hours 3 hours 4 hours 5+ hours

How long has it been since you last drank a beverage?
1 hour 2 hours 3 hours 4 hours 5+ hours

How full do you currently feel?
Not at all full Somewhat full Very full